PHOTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATION IN THE VICINITY OF THE LIBBEY-ST. CLAIR GLASSWORKS, WALLACEBURG, ONTARIO ON AUGUST 19, 1987

SEPTEMBER 1990

Ontario
Environment
Environnement

ISBN 0-7729-6279-0

PHYTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATION IN THE VICINITY OF THE LIBBEY-ST. CLAIR GLASSWORKS, WALLACEBURG, ONTARIO ON AUGUST 19, 1987

Report prepared by:
D.S Harper
Phytotoxicology Section
Air Resources Branch

SEPTEMBER 1990

Copyright: Queen's Printer for Ontario, 1990
This publication may be reproduced for non-commercial purposes with appropriate attribution

PIBS 1262
log 88-2231-153

INTRODUCTION

Staff of the Phytotoxicology Section have conducted vegetation assessment surveys in the Forhan Street South industrial park in Wallaceburg since August, 1976. During the intervening 12 years vegetation in the area has been examined for air pollutant injury and sampled for fluoride, boron and various heavy metals emitted by several different industrial sources. Problems associated with excessive fluoride and chromium concentrations in tree foliage have been solved through effective abatement measures taken by the industries involved. Boron concentrations in tree foliage, however, have remained high in recent years at sites near the Libbey-St. Clair Glassworks on Forhan St. South. Boron is emitted from the Glassworks during the manufacture of borosilicate glass.

Each year, near the middle of August, maple tree (Manitoba, silver or Norway) foliage was examined for boron-induced injury and samples of tree foliage sampled for boron analysis. From 1976 to 1984 no injury associated with boron accumulation was observed on sensitive vegetation, in particular Norway maples. In 1985 boron injury was first observed on a Norway maple immediately south of the Glassworks. In 1986 typical boron injury symptoms were observed at that site plus another site immediately north of the Glassworks.

SURVEY DESIGN

On August 19, 1987, as in previous years, Messrs. R.D. Jones and D.S. Harper examined foliage of maple trees for boron injury at 12 sites within 1 km of the Glassworks. Based on the location of the company perimeter fence and the location of the security control booth it appears that sampling site 1 is now on Libbey-St. Clair property. At each site the leaf samples were collected in duplicate into clean plastic bags for delivery to the Phytotoxicology Section vegetation processing laboratory in Toronto. Samples were oven dried at 60^{o}C, ground and submitted to the Laboratory Service Branch, Inorganic Trace Contaminants Section for boron analysis.

In 1986 soils were sampled from the 0-5 cm depths in the root zones of trees from which foliar samples were taken at sampling Sites 1, 10 and 11. Analysis of these soils for plant available boron, as estimated by hot water extraction prior to analysis of the extract, revealed the presence of boron concentrations significantly higher than background levels. The soil component of the survey was expanded in 1987 to included soil sampling at 10 of the 12 vegetation collection stations (no soils were collected at Sites 6 and 7). As in 1986 the soils were delivered to the Phytotoxicology Section processing laboratory for submission to the Laboratory Service Branch, Inorganic Trace Contaminants Section for boron extraction (hot water) and analysis.

OBSERVATIONS AND ANALYTICAL RESULTS

Boron-induced injury was observed on tree foliage at two sites near the Libbey-St. Clair glassworks. The injury appeared typically as intercostal and/or marginal necrosis on up to 10% of the leaf area on the affected trees. On Norway maple trees at sampling Sites 1 and 10 the injury was both intercostal and marginal. On the silver maple tree at sampling Site 10 the injury appeared largely as an intercostal spotting. This difference is symptom expression is consistent with observations made around other industrial sources of airborne boron. This was the first time that injury had been observed on a silver maple tree at this site.

The results of the vegetation analyses are attached in Table 1, together with comparable results for the previous 5 years. In order to compare the results from year to year, mean values for all results from sampling Sites 1, 5, 10, and 15 are shown at the bottom of the table. Although some variability from site to site over the years is apparent, the means suggest that there was little change in the overall level of contamination between 1982 and 1987. The Phytotoxicology Upper Limit of Normal (ULN) for boron in urban tree foliage is shown also at the bottom of each year's column of results. An explanation of the derivation of ULN's is attached as Appendix I. Boron in tree foliage exceeded the ULN for boron at 6 sites in 1987 compared to 6 sites in 1984, 5 sites in 1986, 4 sites in 1983 and 3 sites in 1985 and 1982. Again, this is a relatively constant pattern since many of the values are close to the ULN and even small, statistically insignificant, changes to a few values can easily change the number of excedences.

As in past years, boron in foliage declined with distance from the Glassworks. This relationship is demonstrated in Figure 1 where results for Manitoba maple foliage have been plotted against distance from the Libbey-St. Clair stacks. The boron concentration in foliage at sampling site 4 appears to be an exception to this trend. Boron results for silver maple samples also show a similar trend.

Analytical results for the soil extracts are presented numerically in Table 2 and graphically as a function of distance from Libbey-St. Clair in Figure 2. Like boron in tree foliage, hot water extractable boron in soil declines with distance from Libbey-St. Clair up to a distance of between 300 and 350 meters from the main process building. Like the Manitoba maple results the notable exception to this observation is the boron concentration in soil at sampling Site 4.

TABLE 1: Results of Analyses of Tree Foliage Collected near Libbey-St. Clair Glassworks, Wallaceburg on August 19, 1987

Sampling Location (site no.)	Tree* Species Sampled	Results of Analysis** of Tree Foliage for Boron, by Sampling Site and Year, 1982 to 1987 (ppm, dry weight)					
		1982	1983	1984	1985	1986	1987
1	NM	170	203	720	435	296	185
2	SM	175	103	96	92	121	100
	MM	135	140	120	145	181	165
3	MM	160	147	155	140	164	
	SM						45
4	MM	140	127	210	125	135	200
	SM	105	117	195	90	54	105
5	SM	175	183	180	145	183	195
6	MM	140	90	97	105	68	135
	SM	65	71	66	41	66	85
7	MM	90	113	110	75	107	125
	SM	80	111	195	125	76	115
10	NM	125	193	145	150	219	155
	MM	450	137	320	215	229	255
	SM	130	130	135	115	144	140
11	MM	105	107	72	52	81	84
	SM	50	65	64	67	72	71
15	MM	420	627	125	430	682	470
16	SM	40	38	36	29	28	36
25	MM	185	170	200	135	125	210
Four Site Means	1,5,10 and 15	245	246	270	248	292	233
Phytotox. Upper Limits of Normal	Urban Tree Foliage	175	175	175	175	175	175

* Tree species: NM (Norway maple); SM (silver maple); MM (Manitoba maple)

** circled analytical values were in excess of the Phytotoxicology ULN for boron in urban tree foliage

FIGURE 1

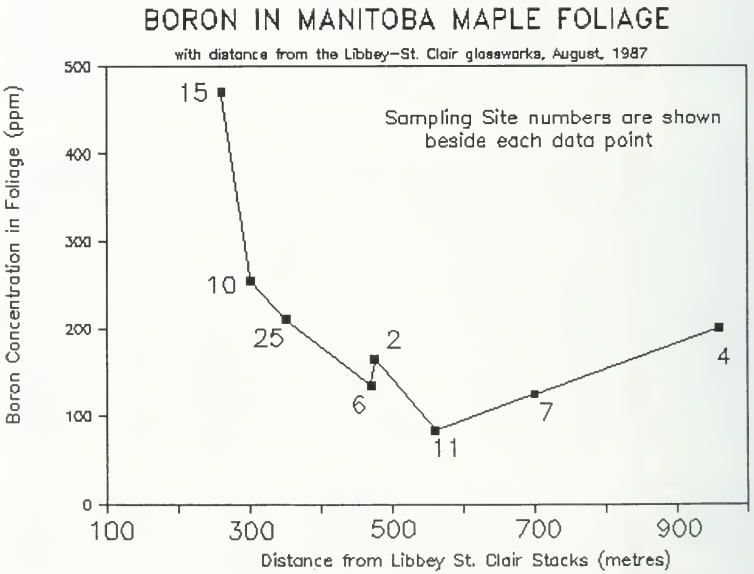
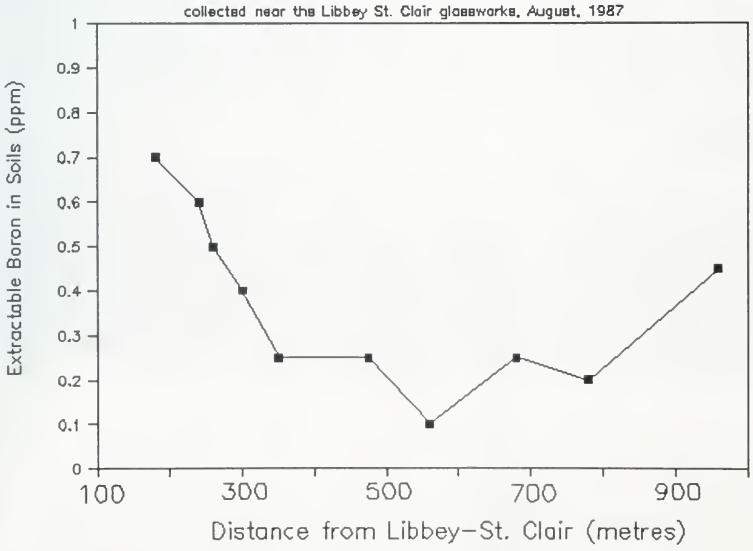

BORON IN MANITOBA MAPLE FOLIAGE
with distance from the Libbey–St. Clair glassworks, August, 1987
Boron Concentration in Foliage (ppm)
500
400
300
200
100
0
Sampling Site numbers are shown beside each data point
15
10
25
6
2
11
7
4
100
300
500
700
900
Distance from Libbey St. Clair Stacks (metres)

TABLE 2: HOT WATER EXTRACTABLE BORON IN SOILS COLLECTED NEAR THE LIBBEY-ST. CLAIR GLASSWORKS, WALLACEBURG, AUGUST, 1987 with comparable data from 1986 where available

Sampling Site Number	Distance from Libbey-St. Clair (metres)	Extractable Boron in Soil, August, 1987 (ppm)	Extractable Boron in Soil, August, 1986 (ppm)
5	180	0.70	
1	240	0.60	0.19
15	260	0.50	
10	300	0.40	0.28
25	350	0.25	
2	475	0.25	
11	560	0.10	0.08
16	680	0.25	
3	780	0.20	
4	960	0.45	

FIGURE 2: EXTRACTABLE BORON IN SOILS



DISCUSSION

As is apparent from the mean values in foliage at sites close to the glassworks, exposure to boron as a result of emissions from the Libbey-St. Clair glassworks have been relatively constant over the past 6 years. On the other hand, boron injury on sensitive tree species has increased at two sites close to the glassworks during the past three years. The explanation of this inconsistency may lie in the soil data. Hot water extractable boron in soil at sampling Site 1 has increased between 1986 and 1987. It has been shown by Phytotoxicology staff using data from around other boron sources and from controlled exposure experiments that sensitive plant species growing in soil containing 1 ppm extractable boron or more, even in the absence of airborne boron, will develop injury symptoms. Boron concentrations in soils near the glassworks are now approaching that threshold. The implication is that not only are boron concentrations in foliage the sum of both airborne and soilborne uptake, but that the soilborne boron may have a greater impact on foliar injury expression than airborne exposure. This concept will require significant future work to verify or reject. The lack of injury on silver maple foliage at Site 5, in spite of the presence of the highest soil boron value, is probably due to the lower sensitivity of silver maple to boron, compared to Norway maple.

Site 4 results, both leaf and soil data, present an interesting anomaly. The site is no closer to the glassworks than are several other sampling sites, including the most northerly site, number 11 which is considered a good control based on both data sets. It is probable that boron contamination at this site is not the result of emissions from Libbey-St. Clair.

SUMMARY

Boron concentrations in maple foliage have remained relatively constant over the past six years in the vicinity of the Libbey-St. Clair glassworks, Wallaceburg. In spite of this apparently stable state, boron injury on maple foliage continues to increase in an area immediately outside the company property. This increase in injury, unassociated with increases in foliar boron may be related to increasing boron (hot water extractable) concentrations in soils. As in previous years, boron in maple foliage declined with distance from Libbey-St. Clair in 1987, to a distance of between 300 and 350 meters from the approximate location of the main stacks.

APPENDIX I

Derivation and Significance of MOE "Upper Limits of Normal" Contaminant Guidelines

The MOE "upper limits of normal" contaminant guidelines essentially represent the expected maximum concentration of contaminants in surface soil (non-agricultural), foliage (tree and shrub), grass, moss bags and or snow from areas of Ontario not subject to the influence of point sources of emissions. "Urban" guidelines are based upon samples collected from centers of minimum 10,000 population. "Rural" guidelines are based upon samples collected from non-built-up areas. Samples were collected by MOE personnel using standard sampling techniques (ref: Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch: Technical Support Sections - NE and NW Regions). Chemical analyses were performed by the MOE Laboratory Services Branch.

The guidelines were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. For those distributions that are "normal", 99% of all contaminant levels in samples from "background" locations (i.e. not affected by point sources nor agricultural activities) will lie below these upper limits of normal. For those distributions that are non-normal, the calculated upper limits of normal will not actually equal the 99th percentile, but nevertheless they lie within the observed upper range of MOE results for Ontario samples.

Due to the large variability in element concentrations which may be present across Ontario, even in background data, control samples should always be collected. This is particularly important for soils, which may show large regional variations in element composition due to difference in parent material. Species of vegetation which naturally accumulate high levels of an element also may be encountered.

It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above normal concentration(s). Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines are not known to be toxic.

MAP OF THE VICINITY OF THE FORHAN STREET SOUTH INDUSTRIAL AREA OF WALLACEBURG, showing the locations of 12 VEGETATION COLLECTION SITES of AUGUST 19, 1987, including those used also for soil collections